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ORIGINAL RESEARCH

Multiple Long-Term Conditions and Disability are Independently Associated with Higher Risk of Fall Among Community Adults: a Cross-Sectional Study

Aqeel M Alenazi[1], Norah A Alhwoaimel[1], Bader A Alqahtani[1], Mohammed M Alshehri[2], Ahmed S Alhowimel[1], Kamlesh Khunti[3], Mohammed S Alghamdi[4]

[1]Department of Health and Rehabilitation Sciences, Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia; [2]Department of Physical Therapy, Jazan University, Jazan, Saudi Arabia; [3]Diabetes Research Centre, University of Leicester, Leicester General Hospital, Gwendolen Road, Leicester, UK; [4]Department of Medical Rehabilitation Sciences, Umm Al-Qura University, Makkah, Saudi Arabia

Correspondence: Aqeel M Alenazi, Department of Health and Rehabilitation Sciences, College of Applied Medical Sciences, Prince Sattam Bin Abdulaziz University, Alt-Kharj, 11942, Saudi Arabia, Tel +966115886354, Email aqeelalenazi.pt@gmail.com; aqeel.alanazi@psau.edu.sa

Background: Previous studies have suggested an association between falls and the presence of Multiple Long-Term Conditions (MLTC) or disabilities. However, there is limited understanding of how these factors independently or collectively contribute to the risk of falls and fear of falling among community-dwelling adults.

Objective: This study examined the independent association between MLTC and the presence of disability with the risk of falls among community adults.

Methods: A cross-sectional study included 324 adults (age ≥ 50). Demographic and clinical data included age, sex, body mass index (BMI), MLTC (≥ two chronic diseases) risk of fall (ie, history of fall in the previous 12-months, number of falls, and recurrent falls). The Barthel Index and Falls Efficacy Scale-International (FES-I) were used to assess disability and fear of fall, respectively.

Results: MLTC (Odds Ratio (OR) 2.50, 95% Confidence Interval (CI) [1.26, 4.95], p=0.009), and disability (OR 1.71, 95% CI [1.04, 2.79], p = 0.034) were independently associated with history of falls. MLTC (Incidence Rate Ratio (IRR) 2.87, 95% CI [1.93, 4.29], p < 0.001) and disability (IRR 1.86 95% CI [1.46, 2.36], p < 0.001) were independently associated with an increased number of falls. MLTC (OR 4.50, 95% CI [1.78, 11.36], p = 0.001) and disability (OR 2.82, 95% CI [1.58, 5.05], p < 0.001) were independently associated with recurrent falls. MLTC (B = 6.45, p < 0.001) and disability (B = 3.05, p = 0.025) were independently associated with increased fear of falling.

Conclusion: This study indicated that both MLTC and disability are independently associated with falls, number of falls and fear of falling in this population.

Keywords: falling, disabilities, impairments, functional limitations, multiple chronic diseases, multimorbidity, Saudi

Introduction

Falls in older adults are a significant public health problem worldwide and can lead to serious injuries, disabilities, and death.[1,2] The prevalence of falls in older adults varies from one study to another, but a systematic review and meta-analysis found that the pooled prevalence of falls in older adults was 26.5% worldwide.[3] The World Health Organization (WHO) report that falls impact approximately 37.3 million individuals globally, leading to a loss of over 38 million disability-adjusted life-years (DALYs).[4] Moreover, falls remained in the top 30 causes of DALYs from the period 1990 to 2017 for both males and females.[3] The estimated fall-related costs are huge and burdensome to individuals, their families, and the healthcare system. In the United States alone, the medical costs of falls in older adults aged 65 and older were approximately $50.0 billion, including fatal and non-fatal falls.[5]

Risk factors associated with falls are complex and interrelated and can have profound physical and psychological impact. Physical injuries such as fractures, bruises, and head injuries occur in approximately 30% of falls, leading to increased morbidity,

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restricted mobility, and loss of independence among community-dwelling adults.[1,6,7] Falls also have psychological implications, including the development of fear of falling, which might lead to reduced activity levels, increased depression, and social isolation.[8,9] Fear of falling is a bidirectional factor that can both increase the risk of falls and be a consequence of falls among community-dwelling adults. Additionally, falls can further exacerbate fear of falling, as the traumatic experience can make individuals more aware of their vulnerability to future falls. This ultimately leads to behavioral changes, such as avoiding perceived risky activities and negatively impacting quality of life and functional ability.[9,10]

Maintaining functional independence while aging is a health priority, especially when individuals have multiple long-term conditions (MLTC). The MLTC is defined as "the co-occurrence of at least two chronic conditions in the same individual"[11] and the term is favored over "multimorbidity" as it is more positively received by patients, better illustrates the co-existence of conditions, and aligns with clinical and research foci.[11] Globally, MLTCs are emerging as a significant public health concern with prevalence rates of 16.6% to 45.3% across nations, associated with adverse clinical and financial outcomes such as hospitalization, disability, mortality, and increased healthcare costs.[12–16] Current evidence suggests that there is a complex relationship between disability and fall risks, particularly in relation to multiple long-term conditions.[17] Older adults with multiple chronic conditions are at a higher risk of falls and fall-related injuries, and falls can be both a cause and a consequence of disability.[18] Additionally, disability was reported to be higher in older adults who reported falls, especially those older than 80 years and have two or more chronic conditions.[18]

In Saudi Arabia, falls among middle-aged and older adults are recognized as a major public health problem. The prevalence of falls among middle-aged and older adults in Saudi Arabia has been estimated to range from 12.6% to 50%.[19–21] Although past reports investigated the risk of fall in the Saudi population, previous evidence is limited to risk of fall among older adults without consideration to middle-aged individuals (50 years and older). Recent evidence has found an increase in the risk of chronic diseases such as diabetes, osteoarthritis, hypertension, cardiovascular diseases, stroke, low physical activity, and other diseases at a younger age.[22–29] This increase might be attributed to sedentary lifestyle,[26] urbanization, and other factors. The increase in chronic conditions necessitates further research related to risk of fall and MLTC in a younger age group. In general, risk factors associated with falls in Saudi Arabia align with existing evidence from around the world. For instance, common risk factors include age, female gender, medications, depression, mobility issues, and chronic conditions.[19–21,30,31] However, the relationship between disability and the risk of falls, particularly in relation to MLTC in Saudi Arabia, has not been extensively explored.[31] Moreover, most existing research on falls in Saudi Arabia has focused on single fall incidents, fear of falling, or specific aspects without considering recurrent falls and the encompassing risk factors within the same study.[30–32]

The aim of this study, therefore, was to investigate the independent association between MLTC and the presence of disability with the risk of falls, including 1) history of falls in the previous 12 months, number of falls, recurrent falls, and fear of falling. We hypothesized that having MLTC and the presence of disability would be strongly and independently associated with a history of falls, an increased number of falls, recurrent falls, and an increased fear of falling. The outcome of this research can provide insights into associated risk factors, contribute to healthcare priorities, and enable the development of preventive and therapeutic strategies for this population.

Methods

Study Design and Participants

A cross-sectional study was conducted to evaluate the association between MLTC and the presence of disability and the risk of falls among adults aged 50 years and older. Data were collected from community adults residing in Saudi Arabia. The inclusion criteria were being aged 50 years or older, the ability to read and write in Arabic, and being a Saudi citizen. Participants were recruited from various community locations, including malls, mosques, clinics, and social gatherings.

Study Tools

Data Collection Form

A standardized data collection form, designed for purpose of the study, was used. The form comprised three parts. Part 1 included demographic information, which are sex, age, and body mass index (BMI). Age was recorded in years and divided into two categories: <65 years and ≥65 years. BMI was calculated by dividing weight in kilograms (kg) by height in meters

squared (m^2). This was further categorized into three groups: normal weight (BMI less than 25), overweight (BMI between 25 and 29.9), and obese (BMI of 30 and above). Part 2 consisted of a list of chronic noncommunicable diseases such as hypertension, diabetes, cardiovascular disease, lung disease, neurological diseases, cancer, and arthritis. Participants were promoted to report other diagnoses if not listed. The total number of chronic diseases was used for this study and categorized into three categories: no chronic disease, one chronic disease, and MLTC (two chronic diseases or more). Part 3 focused on falls, comprising two questions: 1) "Have you fallen in the past 12 months"? and 2) "Have you experienced repeated falls (two or more) in the last 12 months"?. Data regarding falls were summarized into three main aspects. First, participants were classified into two categories based on *history of falls*: those who had experienced one or more falls in the past year (fallers) and those who had not (non-fallers). Second, we recorded the exact *number of falls* for participants who reported any falls within the last year. Third, based on these data, individuals were further categorized as recurrent fallers (experiencing two or more falls in the previous year) or non-recurrent fallers (one or zero falls in that period).

Falls Efficacy Scale International (FES-I)

Fear of falling was measured using the Arabic version of the Falls Efficacy Scale International (FES-I).[33] The FES-I comprised of 16-item self-report questions that include the 10 original items from the FES and 6 more demanding items that assess walking on slippery, uneven or sloping surfaces, visiting friends or relatives, going to a social event or going to a crowded place. Falls efficacy is rated on four-point Likert scale, ranging from 1 (not in the least concerned) to 4 (very concerned). The total FES-I score ranges from 7 (no concern about falling) to 28 (severe concern about falling). The Arabic version of FES-I demonstrated good validity and reliability in community-dwelling elderly Palestinians[33] and individuals with vestibular disorders in Saudi Arabia.[34]

The Barthel Index (BI)

The Barthel Index (BI) is self-report questionnaire designed to assess performance in activities of daily living (ADL).[35] It includes 10 items related to basic daily activities (eg, feeding, bathing) with a focus on functional independence. Each item can be scored from 0 to 15; however, the rating scale is not consistent for all items because it depends on the nature of the item being asked. The total score of the index is the sum of raw scores of all items and ranges from 0 (complete dependence) to 100 (complete independence). For the current study, any participant with a score less than 100 was considered as having disability. Thus, this variable is converted to binary (<100 indicates presence of disability, 100 indicates no disability). This approach has been used in prior research using disability scales on community-dwelling older adults.[36–39]

The validity and reliability of the BI was established for geriatric populations[40] and languages.[41–43] At the time of the study, no Arabic version of the BI was available. Therefore, we performed a cross-cultural adaptation of the BI using guidelines by Beaton et al.[44] The results of this process are being considered for publication elsewhere. In brief, the cross-cultural adaptation included 5-steps: forward translation, synthesis of translation, backward translation, expert committee review, and pre-final version testing. The Arabic version of BI demonstrated high internal consistency (Cronbach's Alpha 0.8), known group validity (adults aged >65 had higher score than adults aged <65, $p < 0.001$, ES = 0.4), convergent validity (positively correlated with ADL index, $r = 0.84$, $p < 0.001$), and divergent validity (negatively correlated FES-I, $r = -0.34$, $p < 0.001$).

Procedure

This study received approval from the Research Ethics Committee at [blinded for review] (Approval No. RHPT/022/010). In compliance with the Declaration of Helsinki's principles, all participants gave informed consent before taking part in the research. Trained physical therapy researchers carried out the data collection process, which involved conducting interviews to gather demographic details, measuring anthropometric properties, and administering self-report questionnaires.

Statistical Analysis

Data are shown as frequencies and percentages for categorical variables and means with standard deviation for continuous variables. All analyses were conducted using IBM SPSS for Mac version 25.0 (SPSS Inc. Chicago, IL, USA) and an alpha level of 0.05 was used across all analyses. Chi square was used for comparing categorical variables between fallers and non-fallers, and independent *t*-test was used for comparing continuous variables between fallers and non-fallers.

Two separate generalized linear models with binary logistic regression were used to examine the independent association between history of falls (fallers vs non-fallers) and recurrence of falls (recurrent fallers vs non-recurrent fallers) with MLTC and disability. Disability is measured by the BI and the variable is converted to binary (<100 indicates presence of disability, 100 indicates no disability). Odds ratios (OR) with associated 95% Confidence Interval (95% CI) were calculated for MLTC and disability. All models were adjusted for age, sex, BMI, MLTC, and disability.

To examine the independent association between number of falls and MLTC and disability, generalized linear model with Poisson regression were used. Disability is measured by the BI and the variable is converted to binary (<100 indicates presence of disability, 100 indicates no disability). Incidence Rate Ratio (IRR) with associated 95% Confidence Interval (95% CI) were calculated for MLTC and disability variables. All models were adjusted for age, sex, BMI, MLTC, and disability.

Multiple linear regression was used to examine the independent association between fear of falling (using FES-I) with MLTC and disability. Disability is measured by the BI and the variable is converted to binary (<100 indicates presence of disability, 100 indicates no disability). All models were adjusted for age, sex, BMI, MLTC, and disability.

Results

A total of 324 participants (mean age 66 ± 7, 59.6% females) were recruited and presented in Table 1. The prevalence of fall was 35.5% among community adults aged 50 years and older. Table 1 shows the demographics and clinical variables. To summarize, older age, female sex, obesity, MLTC, presence of disability, and fear of falling were significantly different between fallers and non-fallers, $p < 0.05$.

The results of the binary logistic regression investigating the independent association between history of falls (fallers vs non-fallers) and MLTC and disability are shown in Table 2. The presence of MLTC was independently and significantly associated with falls (OR 2.50, 95% CI [1.26, 4.95], p = 0.009) after adjustments for age, sex, BMI, and

Table 1 Participants' Demographics and Clinical Factors

Factors	Non fallers (n=209)	Fallers (n=115)	P-value*
Age categories, n (% within fallers and non-fallers)			0.009
< 65 years	128 (61.2)	53 (46.1)	
≥ 65 years	81 (38.8)	78 (54.5)	
Sex, females, (% within fallers and non-fallers)	114 (54.5)	62 (53.9)	0.018
BMI, categories (% within fallers and non-fallers)			0.042
Normal	63 (30.1)	20 (17.4)	
Overweight	79 (37.8)	51 (44.3)	
Obese	67 (32.1)	44 (38,3)	
MLTC (% within fallers and non-fallers)			0.002
No chronic disease	57 (27.3)	15 (13.0)	
One chronic disease	63 (30.1)	29 (25.2)	
MLTC	89 (42.6)	71 (61.6)	
Barthel Index for disability			
No	118 (56.5)	45 (39.1)	0.004
Yes	91 (43.5)	70 (60.9)	
FES-I (mean±SD)	32.88±12.41	38.73±13.28	<0.001

Notes: *p-value was based on Chi-Square for categorical variables or independent *t*-test for continuous variables.
Abbreviations: BMI, Body Mass Index; MLTC, Multiple long-term conditions; SD, Standard Deviation; FES-I, Fall Efficacy Scale International.

Table 2 Binary Logistic Regression for History of Falls (Fallers and Non-Fallers) with MLTC and Disability

n=324	OR [95% CI]	*P*-value
MLTC	2.50 [1.26, 4.95]	0.009
One chronic disease	1.67 [0.80, 3.52]	0.175
No chronic disease	Ref	Ref
Disability	1.71 [1.04, 2.79]	0.034

Notes: The model was adjusted for age, sex, BMI, disability, and MLTC.
Abbreviations: OR, odds ratio; CI, confidence interval; MLTC, multiple long-term conditions.

disability. The presence of disability (a score of <100 on Barthel index) was independently and significantly associated with falls (OR 1.71, 95% CI [1.04, 2.79], p = 0.034) after adjustments for age, sex, BMI, and MLTC.

The results of the Poisson regression examining the independent association between number of falls with MLTC and disability are shown in Table 3. The presence of MLTC was independently and significantly associated with an increased number of falls (IRR 2.74, 95% CI [1.83, 4.10], p < 0.001), after adjustments for age, sex, BMI, and disability. The presence of disability was independently and significantly associated with an increased number of falls (IRR 1.86 95% CI [1.46, 2.36], p < 0.001), after adjustments for age, sex, BMI, and MLTC.

The results of the binary logistic regression examining the independent association between recurrent falls (two falls or more) with MLTC and disability are shown in Table 4. The presence of MLTC was independently and significantly associated with recurrent falls (OR 4.18, 95% CI [1.64, 10.63], p = 0.001) after adjustments for age, sex, BMI, and

Table 3 Poisson Regression for Number of Falls with MLTC and Disability

n=324	IRR [95% CI]	*P*-value
MLTC	2.74 [1.83, 4.10]	<0.001
One chronic disease	1.81 [1.17, 2.80]	0.004
No chronic disease	Ref	Ref
Disability	1.86 [1.46, 2.36]	<0.001

Notes: The model was adjusted for age, sex, BMI, disability, and MLTC.
Abbreviations: IRR, Incidence rate ratio; CI, confidence interval; MLTC, multiple long-term conditions.

Table 4 Binary Logistic Regression for Recurrent Falls (2 or More Falls) with MLTC and Disability

n=324	OR [95% CI]	*p*-value
MLTC	4.18 [1.64, 10.63]	0.003
One chronic disease	2.34 [0.85, 6.42]	0.10
No chronic disease	Ref	Ref
Disability	2.82 [1.58, 5.05]	<0.001

Notes: The model was adjusted for age, sex, BMI, disability, and MLTC.
Abbreviations: OR, odds ratio; CI, confidence interval; MLTC, multiple long-term conditions.

Table 5 Linear Regression for FES-I versus MLTC and Disability

n=324	B (SE)	*P*-value
MLTC	6.52 (1.76)	<0.001
One chronic disease	2.43 (1.88)	0.20
No chronic disease	Ref	Ref
Disability	3.05 (1.36)	0.025

Notes: The model was adjusted for age, sex, BMI, disability, and MLTC.
Abbreviations: B, Unstandardized coefficients; SE, Standard error; MLTC, multiple long-term conditions.

disability. The presence of disability was independently and significantly associated with recurrent falls (OR 2.82, 95% CI [1.58, 5.05], $p < 0.001$), after adjustments for age, sex, BMI, and MLTC.

The results of the multiple linear regression for the association between fear of falling using FES-I with MLTC and disability are shown in Table 5. The presence of MLTC was independently and significantly associated with increased fear of falling ($B = 6.52$, $p < 0.001$) after adjustments for age, sex, BMI, and disability. The presence of disability was independently and significantly associated with increased fear of falling ($B = 3.05$, $p = 0.025$) after adjustments for age, sex, BMI, and MLTC.

Discussion

The current study examined the association between Multiple Long-Term Conditions (MLTC) and disability in relation to the risk of falls among community-dwelling adults aged 50 and above in Saudi Arabia. It was found that MLTC was associated with a history of falls, a higher frequency of falls, recurrent falls, and fear of falling in this population, independent of disability. Furthermore, disability also demonstrated an independent association with falls, an increased frequency of falls, recurrent falls, and fear of falling, irrespective of MLTC. The MLTC was strongly associated with risk of falls (history of falls, number of falls, recurrent falls, and fear of falling) compared to disability. Although previous research used different classifications for the Barthel Index, for the current study, any participant with a score less than 100 was considered as having disability as this approach has been used in prior research using disability scales on community-dwelling older adults.[36–39]

In the current study, we found that individuals with MLTC (those with ≥2 chronic diseases) are 2.5 times more likely to fall than those without a chronic disease. This is consistent with earlier reports by Yan et al[45] and You et al[46] Yan et al reported that patients with two, and ≥3 chronic diseases had an 85%, and 175% increased risk of falls, respectively, compared with older adults without chronic conditions.[45] You et al conducted a population-based study comprising 7774 individuals aged ≥60 years demonstrated that individuals with MLTC had a higher risk of falls compared with those without chronic diseases, suggesting that chronic diseases might have cumulative effects on the occurrence of falls.[46] However, this study did not examine this association independently from disability nor explored the association between disability and risk of falls. Our study bridged this gap, identifying independent associations of MLTC and disability with the risk of falls. Furthermore, our finding that MLTC are associated with a higher number of falls, including repeated falls is consistent with previous studies that noted a higher fall rate among older adults with a chronic condition as opposed to those without chronic diseases.[47,48] For instance, a cross-sectional study from Finland reported that multiple comorbidities are linked with higher incidence and recurrence rates of falls in older adults aged ≥65 years, potentially suggesting that chronic diseases might cumulatively contribute to the occurrence of falls.[47]

Our findings demonstrate that disability is associated with a history of falls, the number of falls, recurrent falls, and fear of falling, thus substantiating that falls in community adults are multifactorial and complex. In the current study, the association between disability and risk of falls was found to be lower compared to the association with MLTC, as evident in the odds ratio and incidence rate ratio. Although we explored the independent association between risk of falls with

MLTC and disability, current evidence suggests an interplay between these outcomes. It has been suggested that MLTC were predictive of a clinically significant decline in physical functions,[49] and associated with long-term disability and slower gait speed in the middle-aged and older adult population.[50] Thus, MLTC may lead to physical decline and exacerbate disability progression, thereby increasing the risk of falls. Additionally, aging is associated with functional decline, such as reductions in muscle mass and strength, poor balance, and mobility challenges, which may contribute to the risk of falls.[51,52] Although not examined in the current study, the use of a greater number of medications due to the presence of multiple comorbidities may explain the association between MLTC and falls.[19,31,32] This could be attributed to drug-related side effects and degradation of drug absorption in the elderly.[53]

Recurrent and sustained fall injuries have been reported as a risk factor for developing a fear of falling among community adults. This fear can both increase the risk of falling and be a consequence of falling among this population. For instance, individuals afraid of falling may avoid certain activities such climbing stairs, which can further decrease their balance. Falls can also lead to a fear of falling due to the traumatic experience, making people more aware of their vulnerability to future falls and leading them to avoid perceived risky activities. This fear negatively impacts quality of life, physical performance, and mental health.[9,10,54] Additionally, our findings show that MLTC is associated with an increased fear of falling, independent of disability. This aligns with a Brazilian study that reported that older adults with MLTC are more likely to fear falling compared to those without chronic conditions.[55] The association can be explained by the mechanisms and consequences of chronic conditions. For example, people with heart and respiratory diseases experience a decline in aerobic capacity, leading to easy fatigue and increased fear of falling, thereby restricting their physical activities.[56,57] Similarly, individuals with diabetes who have reduced skin sensitivity, especially in the plantar region, may experience an increased fear of falling during daily activities.[58]

Our study provides implications for clinical practice and research. Health care providers are encouraged to adopt a comprehensive approach in managing chronic conditions and physical disabilities through screening for MLTC and assessing disability levels to identify those at higher risk of falls. Additionally, patient-centered and multidisciplinary approaches in healthcare systems are recommended to develop management strategies to prevent falls among older adults. Future research is warranted to explore a multivariate model of determinants of falls in community adults aged 50 years and older that encompasses the domains of International Classification of Functioning, Disability and Health (ICF) framework.[59] Future work should investigate fall prevention programs influence on falls in this population with MLTC and disability.

This study has some limitations that should be considered. First, the study used a cross-sectional design, through which was not possible to confirm whether the diagnosis of chronic diseases occurred before or after an instance of falling or the development of a fear of falling. As such, this study can only establish an association, and no causality can be inferred between MLTC and falls or fear of falling. Second, the study did not consider the severity of chronic diseases, which can influence the risk of falling and the fear of falling, when defining MLTC. Another limitation is the classification of the Barthel Index. Barthel index has different classifications. However, our sample was small and included relatively younger age recruited from the community. Therefore, the main focus was on any kind of disability for this younger and community population rather than classifying the disability with relation to risk of fall. Future research should examine the classifications of disability along with MLTC with risk of fall in this population. Lastly, the information about chronic conditions and occurrences of falls was collected through self-reported questions, which may be subject to recall bias, especially among older adults.

Conclusion

The study explored the association between Multiple Long-Term Conditions (MLTC) and disability with the risk of falls among community-dwelling adults aged 50 and above in Saudi Arabia. The findings revealed that both MLTC and disability were independently and significantly associated with a history of falls, increased frequency of falls, recurrent falls, and fear of falling. However, MLTC demonstrated a stronger association with risk of falls compared to disability. The study supports previous findings that individuals with MLTC are more likely to experience falls and highlighted that disability also contributes to the risk of fall. The findings also suggested a potential interplay between MLTC and disability, with MLTC potentially leading to physical decline and exacerbating disability progression, thereby increasing

the risk of falls. The study highlighted the multifactorial and complex nature of falls among community adults and the association between chronic conditions and an increased fear of falling.

Data Sharing Statement

The data will be available from the corresponding author based upon a reasonable request.

Ethics Committee Approval Statement

This study was approved by the Research Ethics Committee at Prince Sattam Bin Abdulaziz University (No. RHPT/022/010).

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Disclosure

The authors report no conflicts of interest in this work.

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